DAA/JOHNSON

SD77-SH-0001
VOLUME 1

SHUTTLE ORBITER OV-102 CDR

SAFETY ANALYSIS REPORT

VOLUME I

MANAGEMENT SUMMARY

27 APRIL 1977

CONTRACT NAS9-14000
IRD SA-045T2
WBS 1.2.5.1

F. J. Attaway

F. J. Attaway, Manager
Program Safety
Space Shuttle Program

Rockwell International
Space Division

ABSTRACT

Hazard Analyses are presented for each subsystem of the Shuttle Orbiter OV-102 configuration, and include: subsystem descriptions, safety features and hazard analysis printout tabs. This report, "Shuttle Orbiter OV-102 CDR Safety Analysis Report," is prepared per IRD SA-045T in support of OV-102 CDR, updated to April 29, 1977, and consists of the following volumes:

SD77-SH-0001-001, Volume I Management Summary
SD77-SH-0001-002, Volume II Structural Systems
SD77-SH-0001-003, Volume III Mechanical Systems
SD77-SH-0001-004, Volume IV Propulsion Systems
SD77-SH-0001-005, Volume V Power Systems
SD77-SH-0001-006, Volume VI Avionics
SD77-SH-0001-007, Volume VII Environment Control & Life Support
SD77-SH-0001-008, Volume VIII Crew Station & Equipment

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

This Safety Analysis Report (SAR) supports the OV-102 CDR. Related SAR's in the Shuttle Orbiter program series include:

SD74-SH-0004	Shuttle Orbiter No. 1 HFT SAR
SD74-SH-0168	Shuttle Orbiter 101 Delta PDR SAR
SD74-SH-0323	Shuttle Orbiter 102 PDR SAR
SD75-SH-0064	Shuttle System PDR SAR
SD75-SH-0135	Shuttle Orbiter 101 CDR SAR
SD76-SH-0038	Shuttle Orbiter 102 Delta PDR SAR

HAZARD ANALYSIS PROCESS

The Hazard Analysis was performed per Rockwell International-Space Division, Reliability and Safety Desk Instruction 400-1. The hazard analysis process, shown in Figure 1, involves the evaluation of the Orbiter in its mission phases by subsystem identified by the System Definition Manual number for hazards in the major hazard groups described in the desk instruction and coded as listed below:

Illness/Injury/Loss of Personnel	AA
Collision/Impact/Erosion	BB
Fire/Explosion/Implosion	CC
Loss of/Unsafe Environment	DD
Crash Landing/Ditching	EE
Loss of Flight Control	FF
Other (Not Defined)	XX

The status classifications presented in the summary are defined in the desk instruction and listed below:

Open (In-Work)	Closed (Eliminated)
Open (Residual)	Closed (Controlled)
	Closed (Accepted)

HAZARD ANALYSIS GROUND RULES

Ground rules used for the hazard analysis are as follows:

1. Hazards are identified per the rationale stated in Desk Instruction 400-1 and NHB 5300.4 (1D-1).
2. Hazard analyses are conducted according to Desk Instruction 400-1 and NHB 5300.4 (1D-1).
3. Hazard levels are as stated in NHB 5300.4 (1D-1).
4. All Criticality 1 FMEA's are analyzed for hazards.
5. All other FMEA's are reviewed for identification of potential hazards.
6. Hazards requiring three or more failures will not be considered.
7. Unless stated in the hazard analysis, equipment is presumed to be operating per specification.

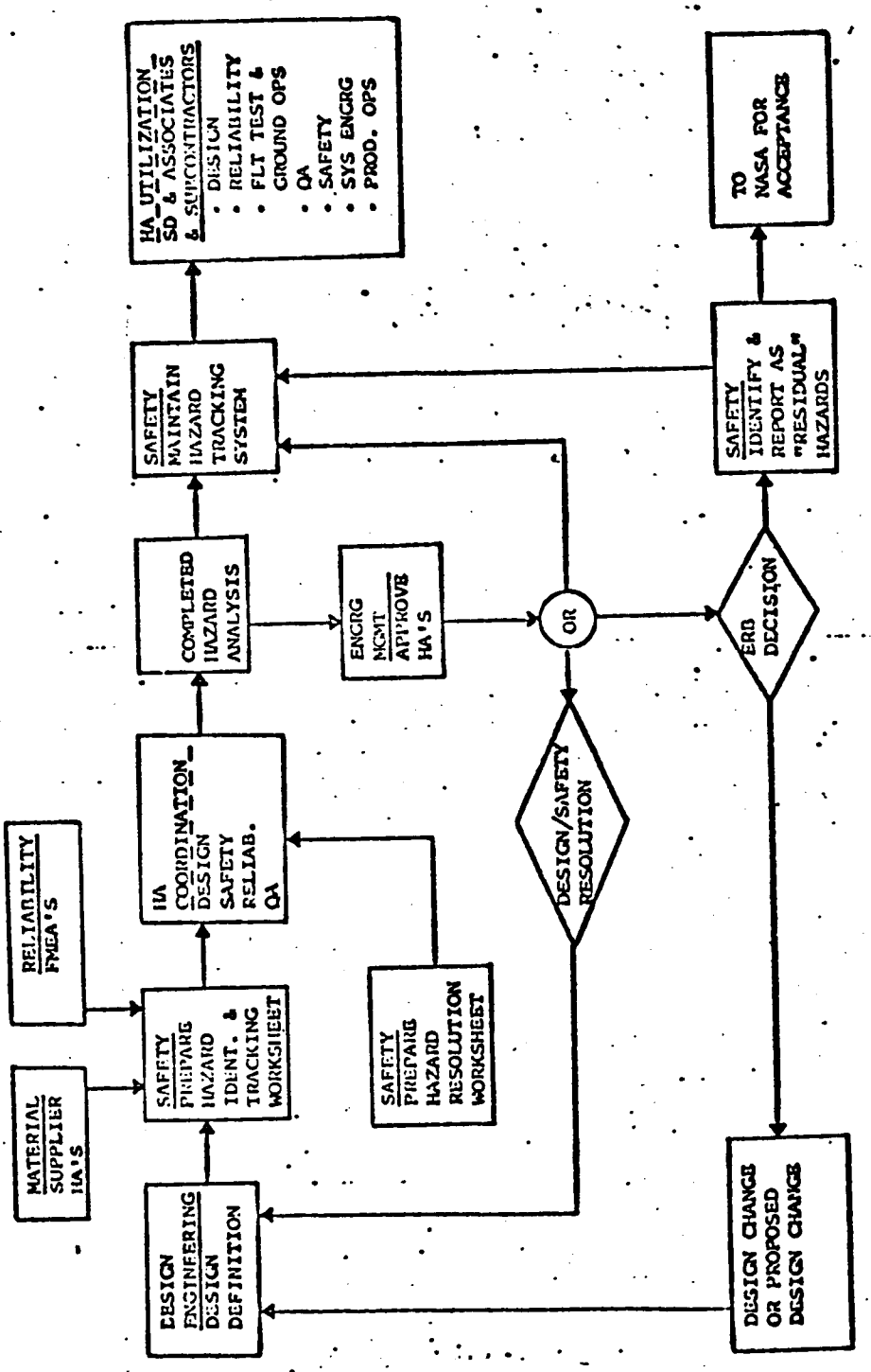

FIGURE 1 - HAZARD ANALYSIS PROCESS

SUMMARY OF HAZARDS

There were 276 potential hazards identified for the Shuttle Orbiter OV-102 subsystems addressed in this CDR submittal. Two hundred and forty-nine are closed, 27 are open and of these open potential hazards, 23 are in-work and 4 are considered residual.

The Shuttle Orbiter OV-102 subsystem hazards are compiled by subsystem group in Table I. Table II lists the potential hazard exposure by mission phase. The totals in Tables I and II are not directly relatable as a potential hazard may be common to more than one mission phase.

Summaries of the Shuttle Orbiter are discussed in the sections that follow and all open potential hazards that are IN WORK or RESIDUAL, are discussed. Tables III through XXIII breakout, in detail, the data compiled in Tables I and II.

TABLE I

HAZARD ANALYSIS COMPILATION
DISTRIBUTION BY ORBITER SYSTEMS
OV-102 CDR

Subsystem Group	Subsystem	Status				Accepted
		Open		Closed		
		In-Work	Residual	Elim.	Controlled	
Structures	Fuselage	1	1	1	11	
	Crew Mod. Struct.	2			2	
	Wing Struct.				1	
	Vert. Tail Struct.				1	
	PV&D				5	
	TPS	3				
	TCS				1	
Mechanical	Landing/Deceleration	1		1	13	
	Separation				3	
	Payload Bay Door				3	
	Payload Retention				2	
	Hydraulics				10	
	Pyrotechnics			2	9	
	Payload Dep. & Ret.				3	
	Flight Control				12	
	Personnel Hatch				4	
	Remote Doors	1		3	5	
Propulsion	Main Propulsion			2	16	
	RCS			1	12	
	OMS				13	
Power	Elect. Power			3	7	
	Auxiliary Power			1	10	

TABLE I (Cont'd.)

HAZARD ANALYSIS COMPILATION
DISTRIBUTION BY ORBITER SYSTEMS
OV-102 CDR

Subsystem Group	Subsystem	Status				
		Open		Closed		
		In-Work	Residual	Elim.	Controlled	Accepted
Avionics	General				8	
	GN&C	3	1		9	
	C&T	1			2	
	D&C				20	
	Data Processing				3	
	EPD&C	4			17	
	Computers			1	3	
ECLSS	Atmosphere Revit.				5	
	Life Support	1			2	
	Smoke Detection				6	
	Active Thermal	1			2	
	Airlock				1	
Crew Station	Mobility Aids					
	Emergency Egress	1			1	
	Stowage		1			
	Equipment Mount.	1				
	Emergency Equip.	1				
	Escape System	2	1			
	Escape Sys. Saf.				11	
					1	
TOTALS		23	4	15	234	0

TABLE II

HAZARD ANALYSIS COMPILATION
DISTRIBUTION BY SHUTTLE/ORBITER MISSION PHASE
OV-102 CDR

Subsystem Group	Mission Phase			
	Prelaunch	Ascent	On-Orbit	Descent
Structures	5	20	6	24
Mechanical	6	25	19	58
Propulsion	21	39	20	23
Power	18	11	5	12
Avionics	31	55	40	55
ECLSS	15	14	17	17
Crew Station	6	13	5	17

NOTE: HA compilation by Mission Phase distribution may exceed the number of HA's as some HA's apply to more than one Mission Phase.

STRUCTURES SYSTEM HAZARD SUMMARY

This volume of the Safety Analysis Report addresses the OV-102 Shuttle Orbiter, Vertical Flight Configuration, Structures System. Twenty-nine HA's have been identified in the structures area. The hazard analysis was performed in parallel with design definition and many of these hazards were identified from information in reports such as the Accident/Incident Data Bank and the JSC 00134 Space Flight Hazard Catalog that was available from previous programs. In most cases the initial design incorporated the safety features to eliminate or control these hazards, and the Safety Analysis Report listing was used as a method to check that the safety features were incorporated in the design. Table III is a summary of the number of hazards in each hazard category for each structures group. Table IV lists each of the hazards identified, by structures subsystem, and their disposition. Table V is a mission phase breakdown of the HA's. Of the twenty-nine hazards identified, twenty-two of these are closed and seven are open, six of which are in an in-work status and one is a residual hazard.

OPEN HAZARDS

Residual

Hazard 1ZXX-0101-4A, "Crash Induced Egress Door Jamming", involves potential structural deformation due to a crash landing that can prevent opening of the side hatch and overhead ejection panels for emergency egress due to indeterminate structural effects. Although this hazard is residual, a study-part of MCR 960, Rev. 2, is being conducted for OV103 and subs with an OV101 and OV102 retrofit effectivity. Precautions associated with this potential hazard will be taken in that rescue personnel, fire fighting equipment and rescue equipment will be available at planned landing sites.

In-Work

1XXX-0101-06, "Star Tracker Door Fails to Close", was originally resolved by a design revision per MCR 1757 which provided for individual fail-safe door design. However, an additional requirement for re-entry capability with a door failed open was mutually agreed upon between JSC/EW and RI/SD (Reference: safety concern no. O-11). RI is to conduct additional thermal studies to determine how this objective can be met.

Hazard 1ZXX-0102-01, "Injury from Sharp Edges, Corners, and Protrusions", addresses contact injuries to personnel during the course of movement within the crew module. This potential hazard is significant to orbital missions under zero "G" conditions. The HA remains in-work to allow continuing inspection of the mock-up through the flight article, to ensure elimination of potential hazards from these sources.

Hazard 1VXX-0102-02, "Delta Pressure Loads on Flight Deck Floor Causing Structural Deflections and Misalignment of Ejection Seat Rails During Seat Ejection", is currently being investigated as part of a rapid decompression effects study per MCR 1964.

Hazards 1YXX-0106-1A, "Loss of Tile", 1YXX-0106-02, "Thermal Seal Failure", and 1YXX-0106-03, "Tile Incompatibility with Orbiter Fluids", are remaining open due to continuance of testing and development in this area.

HAZARD GROUP APPLICATION MATRIX

STRUCTURES

HAZARD GROUP	CODE	FUS	CREW MOD. STRUCT.	WING STRUCT.	VERT. TAIL STRUCT.	PV&D	TPS	TCS
LOSS OF PERSONNEL	AA	1	1	N/A	N/A	N/A	N/A	N/A
COLLISION/IMPACT	BB	1	2	N/A	N/A	N/A	N/A	N/A
FIRE/EXPLOSION	CC	4	N/A	N/A	N/A	1	2	1
LOSS OF/UNSAFE ENVIRONMENT	DD	N/A	N/A	N/A	N/A	3	N/A	N/A
LOSS OF FLIGHT CONTROL	FF	7	N/A	1	1	1	1	N/A
LOSS OF MISSION	XX	1	N/A	N/A	N/A	N/A	N/A	N/A

N/A - Not applicable

TABLE III

TABLE IV
HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102

SUBSYSTEM GROUP	STRUCTURES

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN – IN-WORK	OPEN – RESIDUAL	CLOSED – ELIMINATED	CLOSED – CONTROLLED	CLOSED – ACCEPTED
FUSELAGE							
1ZXX-0101-01-1A	FF	Fwd Fus Structure Failure				X	
1ZXX-0101-01-2A	FF	Mid Fus Structure Failure				X	
1ZXX-0101-01-3A	FF	Aft Fus Structure Failure				X	
1YXX-0101-01-4A	FF	Payload Doors Fail to Close				X	
1ZXX-0101-2A	FF	Tail Cone Separation, Captive Flight				X	
1ZXX-0101-3A	FF	Tail Cone Fitting Failure				X	
1ZXX-0101-4A	AA	Crash Induced Egress Door Jamming		X			
1YXX-0101-05-01	CC	Fwd Fus Tanks Att. Fitting Fail.				X	
1ZXX-0101-05-2A	CC	Mid-Body P/L Att. Fitting Fail.				X	
1ZXX-0101-05-3A	CC	Aft Fus Tank Att. Fitting Fail				X	
1YXX-0101-06	CC	Star Tracker Door Fails to Close	X				
1YXX-0101-7A	XX	T-0 Umbilical Doors Fail to Close			X		
1YXX-0101-8A	FF	ET/Orb Umbilical Door Fail				X	
1ZXX-0101-09	BB	Crew Module Collapse During Ejection				X	
CREW MODULE STRUCTURE							
1ZXX-0102-01	AA	Sharp Edges, Corners, Protrusions	X				
1VXX-0102-02	BB	Floor Deflection During Ejection	X				
1ZXX-0102-3A	BB	Egress Device Instl. Failure				X	
1YXX-0102-04	FF	Debris Obstruction of Controls				X	
WING STRUCTURE							
1ZXX-0103-1A	FF	Structural Failure				X	
VERTICAL TAIL STRUCTURE							
1ZXX-0104-1A	FF	Structural Failure				X	
PURGE, VENT AND DRAIN SUBSYSTEM							
1ZXX-0105-1B	DD	Corrosion due to Inadequate Drainage				X	
1ZXX-0105-2B	FF	Struct. Failure From Delta Pressures				X	
1YXX-0105-3A	DD	Loss of Thermal Window Panes				X	
1YXX-0105-4A	DD	Loss of Cabin Pres Thru Vent Lines				X	
1YXX-0105-5A	CC	Active Vent Doors Fail to Close				X	
THERMAL PROTECTION SYSTEM							
1YXX-0106-1A	CC	Loss of Tile		X			
1YXX-0106-02	FF	Thermal Barrier Failure		X			
1YXX-0106-03	CC	Tile Incompatibility with Orbiter Fluids		X			
THERMAL CONTROL SYSTEM							
1YXX-0107-1A	CC	Entrapment of Combustible Fluids				X	

TABLE V

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: STRUCTURES

HAZARD NUMBER	PROBLEM DESCRIPTION
PRELAUNCH	
1ZXX-0102-01	Sharp Edges, Corners Protrusions
1ZXX-0102-3A	Egress Device Instl Failure
1ZXX-0105-1B	Corrosion from Inadequate Drainage
1YXX-0106-03	Incompatibility with Orbiter Fluids
1YXX-0107-1A	Entrapment of Combustible Fluids
LIFT OFF THRU ORBIT	
1ZXX-0101-01-1A	Fwd Fus Structure Failure
1ZXX-0101-01-2A	Mid Fus Structure Failure
1ZXX-0101-01-3A	Aft Fus Structure Failure
1YXX-0101-05-01	Fwd Fus Tanks Att Ftg Failure
1ZXX-0101-05-2A	Mid Body P/L Att Ftg Failure
1ZXX-0101-05-3A	Aft Fus Tanks Att Ftg Failure
1YXX-0101-06	Star Tracker Door Fails Open
1YXX-0101-7A	T-0 Umbilical Door Fails Open
1YXX-0101-8A	ET/Orb Umbilical Door Failure
1ZXX-0101-09	Crew Mod. Collapse During Eject
1ZXX-0102-01	Sharp Edges, Corners, Protrusions
1VXX-0102-02	Floor Deflection During Ejection
1ZXX-0103-1A	Structural Failure
1ZXX-0104-1A	Structural Failure
1ZXX-0105-1B	Corrosion from Inadequate Drainage
1ZXX-0105-2B	Struct Fail from Delta Pressures
1YXX-0105-3A	Loss of Thermal Window Panes
1YXX-0105-4A	Cabin Pressure Loss Thru Vent Lines
1YXX-0106-03	Incompatibility with Orbiter Fluids
1YXX-0107-1A	Entrapment of Combustible Fluids
ON ORBIT	
1YXX-0101-06	Star Tracker Door Fails Open
1ZXX-0102-01	Sharp Edges, Corners, Protrusions
1ZXX-0105-1B	Corrosion from Inadequate Drainage
1YXX-0105-3A	Loss of Thermal Window Panes
1YXX-0105-4A	Cabin Pressure Loss Thru Vent Lines
1YXX-0105-5A	Active Vent Doors Fail Open

TABLE V

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: STRUCTURES

HAZARD NUMBER	PROBLEM DESCRIPTION
DE-ORBIT THRU LANDING	
1ZXX-0101-01-1A	Fwd Fus Structure Failure
1ZXX-0101-01-2A	Mid Fus Structure Failure
1ZXX-0101-01-3A	Aft Fus Structure Failure
1YXX-0101-01-4A	P/L Doors Fail to Close
1ZXX-0101-4A	Crash Induced Egress Door Jamming
1YXX-0101-05-01	Fwd Fus Tanks Att Ftg Failure
1ZXX-0101-05-2A	Mid Body P/L Att Ftg Failure
1ZXX-0101-05-3A	Aft Fus Tanks Att Ftg Failure
1YXX-0101-06	Star Tracker Door Fails Open
1ZXX-0101-09	Crew Mod Collapse During Eject
1ZXX-0102-01	Sharp Edges, Corners, Protrusions
1VXX-0102-02	Floor Deflection During Ejection
1ZXX-0102-3A	Egress Device Instl Failure
1YXX-0102-04	Debris Obstruction of Controls
1ZXX-0103-1A	Structural Failure
1ZXX-0104-1A	Structural Failure
1ZXX-0105-1B	Corrosion from Inadequate Drainage
1ZXX-0105-2B	Struct Fail from Delta Pressure
1YXX-0105-4A	Cabin Pressure Loss thru Vent Lines
1YXX-0105-5A	Active Vent Doors Fail Open
1YXX-0106-1A	Loss of Tile
1YXX-0106-02	Thermal Barrier Failure
1YXX-0106-03	Incompatibility with Orbiter Fluids
1YXX-0107-1A	Entrapment of Combustible Fluids

MECHANICAL SYSTEM HAZARD SUMMARY

This volume of the Safety Analysis Report addresses the OV-102 Shuttle Orbiter, Vertical Flight Configuration, Mechanical System. Seventy-two HA's have been identified in the mechanical area. The hazard analysis was performed in parallel with design definition and many of these hazards were identified from information in reports such as the Accident/Incident Data Bank and the JSC 00134 Space Flight Hazard Catalog that was available from previous programs. In most cases the initial design incorporated the safety features to eliminate or control these hazards, and the Safety Analysis Report listing was used as a method to check that the safety features were incorporated in the design. Table VI is a summary of the number of hazards in each hazard category for each mechanical group. Table VII lists each of the hazards identified, by mechanical subsystem, and their disposition. Table VIII is a mission phase breakdown of the HA's. Of the seventy-two hazards identified, seventy of these are closed and two are open and in an in-work status. There are no residual hazards.

OPEN HAZARD - IN-WORK

Hazard 1ZXX-0201-5A, "Personnel Injury While Installing Landing Gear Locks", involves ground crew injury while attempting to install the pins for the landing gear, e.g., fragmentation from rupture. Hazard will remain open until operational procedures identify the safety precautions required to control hazards associated with this scheduled event.

Hazard 1YXX-0211-3C, "Star Tracker Door Fails to Close". The potential hazard that could occur during the re-entry phase of the mission is the creation of an unsafe environment in the star tracker (ST) installation area. A requirement for re-entry capability with a door failed open was mutually agreed upon between JSC/EW and RI/SD (reference Safety Concern No. O-11). RI is to conduct additional thermal studies to determine how this objective can be met.

HAZARD GROUP APPLICATION MATRIX

MECHANICAL

Hazard Group	Code	Landing Decel.	Docking Module	Separation	Payload Bay Door	Payload Retention	Hydraulics	Pyro's	Payload Deployment & Retrieval	Aero Flt. Cont.	Pers. Hatch	Remote Operated Doors
Loss of Personnel	AA	1	N/A	1	2	1	N/A	6	2	N/A	3	1
Collision/ Impact	BB	N/A	N/A	1	N/A	1	N/A	2	1	N/A	N/A	N/A
Fire/Explosion/ Implosion	CC	N/A	N/A	1	N/A	N/A	3	1	N/A	N/A	N/A	3
Loss of Unsafe Environment	DD	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	1	2
Crash Landing	EE	13	N/A	N/A	1	N/A	4	2	N/A	1	N/A	N/A
Loss of Flight Control	FF	N/A	N/A	N/A	N/A	N/A	3	N/A	N/A	10	N/A	2
Loss of Mission	XX	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1

N/A - Not applicable

TABLE VI

TABLE VII

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR

SUBSYSTEM GROUP	MECHANICAL SYSTEMS

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS OPEN: IN-WORK	STATUS OPEN: RESIDUAL	STATUS CLOSED: ELIMINATED	STATUS CLOSED: CONTROLLED	STATUS CLOSED: ACCEPTED
LANDING/DECELERATION SUBSYSTEM							
1ZXX-0201-1F	EE	LG Fails to Extend				X	
1ZXX-0201-1F-01	EE	LG Door Fails to Open				X	
1ZXX-0201-2F	EE	Collapse of LG				X	
1ZXX-0201-2F-01	EE	Structural Failure of Shock Strut				X	
1ZXX-0201-2F-02	EE	Drag Brace Failure				X	
1ZXX-0201-2F-03	EE	MLG Torque Arms Failure				X	
1ZXX-0201-2E-04	EE	Structural Failure of Lock Braces				X	
1ZXX-0201-2E-05	EE	Structural Failure of Trunnion Ftgs.				X	
1ZXX-0201-2E-06	EE	Structural Failure of Trunnion Assys.				X	
1ZXX-0201-3F	EE	Orbiter Runs Off Runway				X	
1ZXX-0201-3F-01	EE	Tire Failure				X	
1ZXX-0201-3E-02	EE	MLG Brake/Skid Control Malfunction				X	
1ZXX-0201-5C	AA	Installation of LG Ground Locks	X				
1ZXX-0201-06	EE	Failure of Drag Chute			X		
1ZXX-0201-7D	DD	LG Door Mechanical Devices Fail				X	
SEPARATION MECHANISM SUBSYSTEM							
1Y3X-0203-1D	BB	Failure of Separation Mechanism				X	
1Y3X-0203-2D	AA	Umbilical Plate Mechanisms Fail				X	
1Y3X-0203-4A	CC	Excessive Leakage of LH_2				X	
PAYLOAD BAY DOOR MECHANISMS							
1YXX-0204-1E	AA	Doors Fail to Close				X	
1YXX-0204-2D	EE	Doors Fail to Open				X	
1YXX-0204-3D	AA	Radiators Fail to Close				X	
PAYLOAD RETENTION							
1Z7X-0205-1C	BB	Structural Failure				X	
1Z7X-0205-2A	AA	Fail to Secure P/L				X	
HYDRAULICS SUBSYSTEM							
1ZXX-0206-1G	CC	Excessive Fluid Leakage				X	
1ZXX-0206-2G	CC	Over/Under Pressurization				X	
1ZXX-0206-3G	FF	Loss of Flight Control				X	
1ZXX-0206-3G-01	FF	Elevon Actuator Failure				X	
1ZXX-0206-3E-02	FF	Malfunction of TVC Actuators				X	
1ZXX-0206-4F	EE	Loss of Hyd. Power to LG/Decel.System				X	
1ZXX-0206-4E-01	EE	MLG/NLG Strut Actuator Failure				X	
1ZXX-0206-4F-02	EE	MLG/NLG Uplock Actuator Malfunction				X	
1ZXX-0206-4F-03	EE	Strut Actuator Cylinder Failure				X	
1YXX-0206-5A	CC	R/SB or B/F PDU Seal Failure				X	

TABLE VII

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR
SUBSYSTEM GROUP	MECHANICAL SYSTEMS

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
PYROTECHNICS SUBSYSTEM							
1ZXX-0207-2G	CC	Ignition Source When Flammable Fluid are Present					X
1ZXX-0207-2E-01	EE	Inadvertent Firing					X
1ZXX-0207-3C	AA	Premature Actuation of Rocket Catapult				X	
1ZXX-0207-6A	AA	Explosive Decompression of CM					X
1VXX-0207-7E	AA	Failure of Pyro C.E. Panel Severance Assys.					X
1VXX-0207-9F	AA	Pyro Energy Transfer System Malfunction					X
1VXX-0207-10E	AA	Failure Thruster Assy. - Escape System					X
1ZXX-0207-11E	EE	Uplock Thruster Assy. Malfunction - LG					X
1VXX-0207-12D	AA	Failure of Rocket Catapult Assy.				X	
1Y3X-0207-13E	BB	Fail to Ignite					X
1Y3X-0207-14D	BB	Premature Firing					X
PAYLOAD DEPLOYMENT AND RETRIEVAL							
1Y7X-208-1B	BB	Loss of Operational Control of RMS					X
1YXX-0208-2C	AA	Loss of Capability to Stow					X
1YXX-0208-3B	AA	Failed Mechanism					X
AERO FLIGHT CONTROL MECH. SUBSYSTEM							
1YXX-0209-2C	DD	Loss of Pressure					X
1ZXX-0209-2D-01	FF	Icing of Probes					X
1YXX-0209-2C-02	FF	Failure of Air Data Probes					X
1ZXX-0209-3F	FF	Failure of Aero Flight Control Mech.					X
1ZXX-0209-4E	FF	Rudder Subsystem Malfunction					X
1ZXX-0209-4E-01	FF	Rudder Power Drive Unit Failure					X
1ZXX-0209-4D-02	FF	Rotary Actuator Binding/Jamming					X
1ZXX-0209-4D-03	FF	Speed Brake Power Drive Unit Failure					X
1ZXX-0209-5D	FF	Body Flap Actuation System Failure					X
1ZXX-0209-5D-01	FF	B/F Rotary Actuator Binding/Jamming					X
1ZXX-0209-5D-02	FF	B/F Power Drive Unit Malfunction					X
1YXX-0209-6A	EE	Failure of Yaw and Brake Pedals					X
PERSONNEL HATCH MECH. SUBSYSTEM							
1YXX-0210-1D	DD	Excess Leakage of Pressure					X
1ZXX-0210-2F	AA	Ingress/Egress Hatch Mechanism Fail					X
1YXX-0210-3C	AA	Failure of Hatch					X
1YXX-0210-5B	AA	Improper Procedure Implemented					X

TABLE VII

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102

SUBSYSTEM GROUP	MECHANICAL SYSTEMS

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
REMOTE OPERATED DOORS							
1YXX-0211-1D	FF	ET/Umbilical Doors Fail to Close					X
1YXX-0211-2B	DD	RCS Doors Fail to Close			X		
1YXX-0211-3C	DD	Star Tracker Doors Malfunctioned	X				
1YXX-0211-4C	CC	Vent Doors Fail to Open					X
1YXX-0211-4B-01	CC	Vent Doors Actuate Prematurely					X
1YXX-0211-5A	XX	Launch Umbilical Doors Fail			X		
1YXX-0211-6A	FF	Fwd RCS Doors Malfunction			X		
1YXX-0211-7C	AA	Vent Doors Fail to Close					X
1YXX-0211-8A	CC	Potential Ignition Sources Present					X

TABLE VIII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: MECHANICAL

HAZARD NUMBER	PROBLEM DESCRIPTION
PRELAUNCH	
1ZXX-0206-1G	Excessive Fluid Leakage
1ZXX-0206-2G	Over/Under Pressurization
1ZXX-0207-2G	Ignition Source When Flammable Fluids are Present
1VXX-0207-3C	Premature Actuation of Rocket Catapult
1ZXX-0210-2F	Ingress/Egress Hatch Mechanism Fail
1YXX-0211-8A	Potential Ignition Sources
LIFTOFF THRU ORBIT	
1YXX-0201-7D	LG Door Mechanical Devices Fail
1Y3X-0203-1D	Failure of Separation Mechanism
1Y3X-0203-2D	Umbilical Plate Mechanisms Fail
1Y3X-0203-4A	Excessive Leakage of LH_2
1Z7X-0205-1C	Structural Failure
1ZXX-0206-1G	Excessive Fluid Leakage
1ZXX-0206-2G	Over/Under Pressurization
1ZXX-0206-3G	Loss of Flight Control
1ZXX-0207-2G	Ignition Source When Flammable Fluids are Present
1ZXX-0207-2E-01	Inadvertent Firing
1VXX-0207-3C	Premature Actuation of Rocket Catapult
1ZXX-0207-6A	Explosive Decompression of CM
1VXX-0207-7E	Failure of Pyro C.E. Panel Severance Assys.
1VXX-0207-9F	Pyro Energy Transfer System Malfunction
1VXX-0207-10E	Failure Thruster Assy. - Escape System
1VXX-0207-12D	Failure of Rocket Catapult Assy.
1Y3X-0207-13E	Fail to Ignite
1Y3X-0207-14D	Premature Firing
1YXX-0209-2C	Loss of Pressure
1YXX-0210-1D	Excessive Leakage of Pressure
1YXX-0211-1D	ET/Umb. Doors Fail to Close
1YXX-0211-4C	Vent Doors Fail to Open
1YXX-0211-4B-01	Vent Doors Actuate Prematurely
1YXX-0211-6A	Fwd RCS Doors Malfunction
1YXX-0211-8A	Potential Ignition Sources Present
ON ORBIT	
1YXX-0201-7D	LG Door Mechanical Devices Fail
1YXX-0204-1E	Doors Fail to Close
1YXX-0204-2D	Doors Fail to Open
1YXX-0204-3D	Radiators Fail to Close

(continued)

TABLE VIII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: MECHANICAL

HAZARD NUMBER	PROBLEM DESCRIPTION
ON ORBIT (Cont.)	
1Z7X-0205-2A	Fails to Secure P/L
1Z7X-0207-2E-01	Inadvertent Firing
1VXX-0207-3C	Premature Actuation of Rocket Catapult
1ZXX-0207-6A	Explosive Decompression of CM
1Y7X-0208-1B	Loss of Operational Control of RMS
1YXX-0208-2C	Loss of Capability to Stow
1YXX-0208-3B	Failed Mechanism
1YXX-0210-1D	Excessive Leakage of Pressure
1ZXX-0210-2F	Ingress/Egress Hatch Mechanism Fail
1ZXX-0210-3C	Failure of Hatch
1ZXX-0210-5B	Improper Procedure Implemented
1YXX-0211-2B	RCS Doors Fail to Close
1YXX-0211-3C	Star Tracker Doors Malfunctioned
1YXX-0211-6A	Fwd RCS Doors Malfunction
1YXX-0211-7C	Vent Doors Fail to Close
DEORBIT THRU LANDING	
1ZXX-0201-1F	LG Fail to Extend
1ZXX-0201-1F-01	LG Door Fails to Open
1ZXX-0201-2F	Collapse of LG
1ZXX-0201-2F-01	Structural Failure of Shock Strut
1ZXX-0201-2F-02	Drag Brace Failure
1ZXX-0201-2F-03	MLG Torgue Arms Failure
1ZXX-0201-2E-04	Structural Failure of Lock Braces
1ZXX-0201-2E-05	Structural Failure of Trunnion Ftgs.
1ZXX-0201-2E-06	Failure of Trunnion Assy.
1ZXX-0201-3F	Orbiter Runs Off Runway
1ZXX-0201-3F-01	Tire Failure
1ZXX-0201-3F-02	MLG Brake/Skid Control Malfunction.
1ZXX-0201-5C	Installation of LG Ground Locks
1ZXX-0201-06	Failure of Drag Chute
1YXX-0201-7D	LG Door Mechanical Devices Fail
1YXX-0204-1E	Doors Fail to Close
1YXX-0204-3D	Radiators Fail to Close
1Z7X-0205-1C	Structural Failure
1Z7X-0205-2A	Failure to Secure Payload (P/L)
1ZXX-0206-1G	Excessive Fluid Leakage
1ZXX-0206-2G	Over/Under Pressurization
1ZXX-0206-3G	Loss of Flight Control

(continued)

TABLE VIII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: MECHANICAL

HAZARD NUMBER	PROBLEM DESCRIPTION
DEORBIT THRU LANDING (Cont.)	
1ZXX-0206-3G-01	Elevon Actuator Failure
1ZXX-0206-3E-02	Malfunction of TVC Actuators
1ZXX-0206-4F	Loss of Hyd. Power to LG/Dec. Subsystem
1ZXX-0206-4E-01	MLG/NLG Strut Actuator Failure
1ZXX-0206-4F-02	MLG/NLG Uplock Actuator Malfunction
1ZXX-0206-4F-03	Strut Actuator Cylinder Failure
1ZXX-0206-5A	R/SB or B/F PDU Seal Failure
1ZXX-0207-2G	Ignition Source When Flam. Flds. are Present
1ZXX-0207-2E-01	Inadvertent Firing
1VXX-0207-3C	Premature Actuation of Rocket Catapult
1ZXX-0207-6A	Explosive Decompression of CM
1VXX-0207-7E	Failure of Pyro C.E. Panel Severance Assys.
1VXX-0207-9F	Pyro Energy Transfer System Malfunction
1VXX-0207-10E	Failure Thruster Assy. - Escape System
1ZXX-0207-11E	Uplock Thruster Assy. Malfunction - LG
1VXX-0207-12D	Failure of Rocket Catapult Assy.
1YXX-0209-2C	Loss of Pressure
1ZXX-0209-2D-01	Icing of Probes
1ZXX-0209-2C-02	Failure of Air Data Probes
1ZXX-0209-3F	Failure of Aero Flight Control Mech.
1ZXX-0209-4E	Rudder Subsystem Malfunction
1ZXX-0209-4E-01	Rudder Power Drive Unit (PDU) Failure
1ZXX-0209-4D-02	Rotary Actuator Binding/Jamming
1ZXX-0209-4D-03	Speed Brake PDU Failure
1ZXX-0209-5D	Body Flap Actuation System Failure
1ZXX-0209-5D-01	Body Flap Rotary Actuator Binding/Jamming
1ZXX-0209-5D-02	B/F PDU Malfunction
1YXX-0209-6A	Failure of Yawl and Brake Pedals
1YXX-0210-1D	Excessive Leakage of Pressure
1ZXX-0210-2F	Ingress/Egress Hatch Mechanism Fails
1ZXX-0210-3C	Failure of Hatch
1ZXX-0210-5B	Improper Procedure Implemented
1YXX-0211-4C	Vent Doors Fail to Open
1YXX-0211-4B-01	Vent Doors Actuate Prematurely
1YXX-0211-5A	Launch Umbilical Doors Fail
1YXX-0211-8A	Potential Ignition Sources Present

PROPULSION SYSTEM HAZARD SUMMARY

This volume of the Safety Analysis Report addresses the OV-102 Shuttle Orbiter, Vertical Flight Configuration, Propulsion System. Forty-four HA's have been identified in the Propulsion area. The hazard analysis was performed in parallel with design definition and many of these hazards were identified from information in reports such as the Accident/Incident Data Bank and the JSC 00134 Space Flight Hazard Catalog that was available from previous programs. In most cases the initial design incorporated the safety features to eliminate or control these hazards, and the Safety Analysis Report listing was used as a method to check that the safety features were incorporated in the design. Table IX is a summary of the number of hazards in each hazard category for each Propulsion group. Table X lists each of the hazards identified, by Propulsion subsystem, and their disposition. Table XI is a mission phase breakdown of the HA's. All forty-four of the identified hazards are closed.

HAZARD GROUP APPLICATION MATRIX

Propulsion Systems

Hazard Group	Code	Main Propulsion	Reaction Control	Orbital Maneuvering
Loss of Personnel	AA	N/A	1	N/A
Collision/Impact	BB	1	N/A	N/A
Fire/Explosion/Implosion	CC	9	7	9
Loss of/Unsafe Environment	DD	N/A	N/A	1
Crash Landing	EE	N/A	N/A	N/A
Loss of Flight Control	FF	8	5	3
Other	XX	N/A	N/A	N/A

N/A - Not Applicable

TABLE IX

TABLE X

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR

SUBSYSTEM GROUP	PROPULSION

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
MAIN PROPULSION							
1YXX-0301-01	CC	Heat Exchanger Coil Rupture				X	
1YXX-0301-02	CC	GOX Rich Aft Compartment				X	
1YXX-0301-03	FF	SSME Chamber Burn Through				X	
1YXX-0301-04	FF	Thrust Vector Control Error				X	
1YXX-0301-05	BB	High Pressure He Gas Flow				X	
1YXX-0301-06	CC	LOX/GOX Uncontrolled Release				X	
1YXX-0301-07	CC	LH_2/GH_2 Uncontrolled Release			X		
1YXX-0301-09	FF	Loss of Hydrogen Fuel Flow				X	
1YXX-0301-10	FF	Loss of Oxygen Flow				X	
1YXX-0301-11	CC	Hydrogen Rich Aft Compartment			X		
1YXX-0301-12	CC	GOX Rich Aft Compartment				X	
1YXX-0301-13	CC	Launch Dynamics - LOX/GOX				X	
1YXX-0301-14	CC	Launch Dynamics - LH_2/GH_2				X	
1YXX-0301-15	FF	SSME Shutdown				X	
1YXX-0301-16	CC	H_2 Vapor Concentrations				X	
1YXX-0301-17	FF	Loss of LH_2 Tank Ullage Pressure				X	
1YXX-0301-18	FF	Loss Hydraulic Actuation				X	
1YXX-0301-19	FF	Loss SSME/SSME's				X	
REACTION CONTROL SUBSYSTEM							
1YXX-0302-01	CC	Thruster Burn Thru				X	
1YXX-0302-02	CC	APS POD Over-Pressurization				X	
1YXX-0302-03	CC	Fwd RCS Operation with Doors Closed			X		
1YXX-0302-04	CC	Hypergolic Reaction in Compartment				X	
1YXX-0302-05	CC	Generation of Hazarcous Atmosphere				X	
1YXX-0302-06	CC	Explosive Rupture of Helium Tank				X	
1YXX-0302-07	CC	Explosive Rupture of Propellant Tank				X	
1YXX-0302-08	FF	Thruster Premature Shutdown				X	
1YXX-0302-09	FF	Thruster Premature Firing				X	
1YXX-0302-10	FF	Thruster Fail to Shutdown				X	
1YXX-0302-11	FF	Thruster Fail to Fire				X	
1YXX-0302-12	FF	Loss of Capability to Separate from ET				X	
1YXX-0302-13	AA	Thruster Inadvertent Firing on Ground				X	
ORBITAL MANEUVER SUBSYSTEM							
1YXX-0303-01	CC	Generation of Hazardous Atmosphere				X	
1YXX-0303-02	CC	APS POD Over-Pressurization				X	
1YXX-0303-03	CC	Hypergolic Reaction in POD				X	
1YXX-0303-04	CC	Explosive Rupture of Propellant Tank				X	
1YXX-0303-05	CC	Explosive Rupture of Nitrogen Tank				X	
1YXX-0303-06	CC	Explosive Rupture of Helium Tank				X	
1YXX-0303-07	CC	OME Burn Thru				X	

(continued)

TABLE X

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR

SUBSYSTEM GROUP	PROPULSION

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
ORBITAL MANEUVER SUBSYSTEM (Cont.)							
1YXX-0303-08A	FF	Loss of Capability to Deplete Propellant				X	
1YXX-0303-09	DD	Hazardous Atmosphere in Payload Bay				X	
1YXX-0303-10	CC	Explosive Rupture of PBK Propellant Tank				X	
1YXX-0303-11	CC	Explosive Rupture of PBK Helium Tank				X	
1YXX-0303-12	FF	Inability to Dump PBK Propellant				X	
1YXX-0303-16	FF	Insufficient Remaining Propellant				X	

TABLE XI

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: PROPULSION

HAZARD NUMBER	PROBLEM DESCRIPTION
PRELAUNCH	
1YXX-0301-02	GOX Rich Aft Compartment
1YXX-0301-06	LOX/GOX Uncontrolled Release
1YXX-0301-09	Loss of Hydrogen Fuel Flow
1YXX-0301-10	Loss of Oxygen Flow
1YXX-0301-16	H_2 Vapor Concentrations
1YXX-0301-17	Loss of LH_2 Tank Ullage Pressure
1YXX-0302-02	Forward RCS Module or APS Pod Overpressurization
1YXX-0302-04	Hypergolic Reaction in RCS Compartment
1YXX-0302-05	Generation of Hazardous Atmosphere
1YXX-0302-06	Explosive Rupture of RCS Helium Tank
1YXX-0302-07	Explosive Rupture of RCS Propellant Tank
1YXX-0302-13	Thruster Inadvertent Firing on Ground
1YXX-0303-01	Generation of Hazardous Atmosphere in APS Pod
1YXX-0303-02	APS Pod Overpressurization
1YXX-0303-03	Hypergolic Reaction in APS Pod
1YXX-0303-04	Explosive Rupture of OMS Propellant Tank
1YXX-0303-05	Explosive Rupture of OMS Nitrogen Tank
1YXX-0303-06	Explosive Rupture of OMS Helium Tank
1Y7X-0303-09	Hazardous Atmosphere in Payload Bay
1Y7X-0303-11	Explosive Rupture of PBK Helium Tank
LIFTOFF THRU ORBIT	
1YXX-0301-01	Heat Exchanger Coil Rupture
1YXX-0301-02,12	GOX Rich Aft Compartment
1YXX-0301-03	SSME Chamber Burn Through
1YXX-0301-04	Thrust Vector Control Error
1YXX-0301-05	High Pressure Helium Gas Flow
1YXX-0301-06	LOX/GOX Uncontrolled Release
1YXX-0301-09	Loss of Hydrogen Fuel Flow
1YXX-0301-10	Loss of Oxygen Flow
1YXX-0301-13	Launch Dynamics - LOX/GOX
1YXX-0301-14	Launch Dynamics - LH_2/GH_2
1YXX-0301-15	SSME Shutdown
1YXX-0301-16	H_2 Vapor Concentrations
1YXX-0301-17	Loss of LH_2 Tank Ullage Pressure
1YXX-0301-18	Loss of Hydraulic Actuation
1YXX-0301-19	Loss of SSME/SSME's

(continued)

TABLE XI

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: PROPULSION

HAZARD NUMBER	PROBLEM DESCRIPTION
LIFTOFF THRU ORBIT (Cont.)	
1YXX-0302-01	RCS Thruster Burn Through
1YXX-0302-02	Forward RCS Module or APS Pod Overpressurization
1YXX-0302-04	Hypergolic Reaction in RCS Compartment
1YXX-0302-05	Generation of Hazardous Atmosphere
1YXX-0302-06	Explosive Rupture of RCS Helium Tank
1YXX-0302-07	Explosive Rupture of RCS Propellant Tank
1YXX-0302-08	RCS Thruster Premature Shutdown
1YXX-0302-09	RCS Thruster Premature Firing
1YXX-0302-10	RCS Thruster Failure to Shutdown
1YXX-0302-11	RCS Thruster Failure to Fire
1YXX-0302-12	Loss of Capability to Separate From ET
1YXX-0303-01	Generation of Hazardous Atmosphere in APS Pod
1YXX-0303-02	APS Pod Overpressurization
1YXX-0303-03	Hypergolic Reaction in APS Pod
1YXX-0303-04	Explosive Rupture of OMS Propellant Tank
1YXX-0303-05	Explosive Rupture of OMS Nitrogen Tank
1YXX-0303-06	Explosive Rupture of OMS Helium Tank
1YXX-0303-07	OMS Engine Burn Through
1YXX-0303-08A	Loss of Capability to Deplete OMS Propellant
1YXX-0303-09	Hazardous Atmosphere in Payload Bay
1Y7X-0303-10	Explosive Rupture of PBK Propellant Tank
1Y7X-0303-11	Explosive Rupture of PBK Helium Tank
1Y7X-0303-12	Inability to Dump PBK Propellant
ON ORBIT	
1YXX-0302-01	RCS Thruster Burn Through
1YXX-0302-02	Forward RCS Module or APS Pod Overpressurization
1YXX-0302-04	Hypergolic Reaction in RCS Compartment
1YXX-0302-05	Generation of Hazardous Atmosphere
1YXX-0302-06	Explosive Rupture of RCS Helium Tank
1YXX-0302-07	Explosive Rupture of RCS Propellant Tank
1YXX-0302-08	RCS Thruster Premature Shutdown
1YXX-0302-09	RCS Thruster Premature Firing
1YXX-0302-10	RCS Thruster Failure to Shutdown
1YXX-0302-11	RCS Thruster Failure to Fire
1YXX-0303-01	Generation of Hazardous Atmosphere in APS Pod
1YXX-0303-02	APS Pod Overpressurization

(continued)

TABLE XI

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: PROPULSION

HAZARD NUMBER	PROBLEM DESCRIPTION
ON ORBIT (Cont.)	
1YXX-0303-03	Hypergolic Reaction in APS Pod
1YXX-0303-04	Explosive Rupture of OMS Propellant Tank
1YXX-0303-05	Explosive Rupture of OMS Nitrogen Tank
1YXX-0303-06	Explosive Rupture of OMS Helium Tank
1YXX-0303-07	OMS Engine Burn Through
1Y7X-0303-09	Hazardous Atmosphere in Payload Bay
1Y7X-0303-10	Explosive Rupture of PBK Propellant Tank
1Y7X-0303-11	Explosive Rupture of PBK Helium Tank
DEORBIT THRU LANDING	
1YXX-0302-01	RCS Thruster Burn Through
1YXX-0302-02	Forward RCS Module or APS Pod Overpressurization
1YXX-0302-04	Hypergolic Reaction in RCS Compartment
1YXX-0302-05	Generation of Hazardous Atmosphere
1YXX-0302-06	Explosive Rupture of RCS Helium Tank
1YXX-0302-07	Explosive Rupture of RCS Propellant Tank
1YXX-0302-08	RCS Thruster Premature Shutdown
1YXX-0302-09	RCS Thruster Premature Firing
1YXX-0302-10	RCS Thruster Failure to Shutdown
1YXX-0302-11	RCS Thruster Failure to Fire
1YXX-0302-13	RCS Thruster Inadvertent Firing on Ground
1YXX-0303-01	Generation of Hazardous Atmosphere in APS Pod
1YXX-0303-02	APS Pod Overpressurization
1YXX-0303-03	Hypergolic Reaction in APS Pod
1YXX-0303-04	Explosive Rupture of OMS Propellant Tank
1YXX-0303-05	Explosive Rupture of OMS Nitrogen Tank
1YXX-0303-06	Explosive Rupture of OMS Helium Tank
1YXX-0303-07	OMS Engine Burn Through
1YXX-0303-08A	Loss of Capability to Deplete Propellant
1Y7X-0303-09	Hazardous Atmosphere in Payload Bay
1Y7X-0303-10	Explosive Rupture of PBK Propellant Tank
1Y7X-0303-11	Explosive Rupture of PBK Helium Tank
1Y7X-0303-12	Inability to Dump PBK Propellant
1YXX-0303-16	Insufficient Remaining OMS Propellant

POWER SYSTEM HAZARD SUMMARY

This volume of the Safety Analysis Report addresses the OV-102 Shuttle Orbiter, Vertical Flight Configuration, Power System. Twenty-one HA's have been identified in the Power area. The hazard analysis was performed in parallel with design definition and many of these hazards were identified from information in reports such as the Accident/Incident Data Bank and the JSC 00134 Space Flight Hazard Catalog that was available from previous programs. In most cases the initial design incorporated the safety features to eliminate or control these hazards, and the Safety Analysis Report listing was used as a method to check that the safety features were incorporated in the design. Table XII is a summary of the number of hazards in each hazard category for each Power group. Table XIII lists each of the hazards identified, by Power subsystem, and their disposition. Table XIV is a mission phase breakdown of the HA's. All twenty-one of the identified hazards are closed.

HAZARD GROUP APPLICATION MATRIX

Power Systems

Hazard Group	Code	Elect. Pwr. Syst.	APU
Loss of Personnel	AA	N/A	1
Collision/Impact	BB	N/A	N/A
Fire/Explosion	CC	8	8
Loss of/Unsafe Env.	DD	1	1
Crash Land.	EE	N/A	N/A
Loss of Flt. Cont.	FF	1	1
Equipment Fail/Damage	XX	N/A	N/A

N/A - Not Applicable

TABLE XII

TABLE XIII
HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR

SUBSYSTEM GROUP	POWER

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS OPEN			STATUS CLOSED	
			IN-WORK	RESIDUAL	ELIMINATED	CONTROLLED	ACCEPTED
EPS							
1YXX-0401-01	CC	Leakage LH_2					
1Y4S-0401-02	CC	Flammable/Exp Atmos.				X	
1YXX-0401-03	CC	LOX Recir. Pump				X	
1ZXX-0401-04	FF	Interrupt. Elect. Pwr.			X		
1YXX-0401-05	CC	Press. Vessel Rupture				X	
1ZXX-0401-06	CC	Gas Vapors at Umbilical				X	
1ZXX-0401-08	CC	Gas Vapors in Mid Fuse.				X	
1ZXX-0401-10	CC	Press. Vessel/Line Rupt.				X	
1YXX-0401-11	DD	Toxic Vapors From Batt.				X	
1YXX-0401-12	CC	H_2 Vapors - Batt. Venting			X		
					X		
APU							
1ZXX-0402-01	CC	Exhaust Duct Rupture					
1ZXX-0402-02	CC	Hydrazine Leakage			X		
1ZXX-0402-03	CC	Turbine Failure				X	
1ZXX-0402-04	AA	Tox./Flamm. Grnd. Atmos.				X	
1ZXX-0402-05	CC	APU Insulation Leak Paths				X	
1ZXX-0402-07	CC	Fitting Leakage N_2H_4				X	
1ZXX-0402-08	CC	H_2 in APU Exhaust				X	
1ZXX-0402-09	FF	Failure to Contain Rotating Parts				X	
1ZXX-0402-10	CC	N_2H_4 Storage Vessel Overpress.				X	
1ZXX-0402-12	CC	Failure of Gas Generator				X	
						X	
1ZXX-0402-15	DD	N_2H_4 Vapors Overboard/Grnd.				X	

TABLE XIV

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: AUXILLIARY POWER

HAZARD NUMBER	PROBLEM DESCRIPTION
PRELAUNCH	
1ZXX-0402-01	Exhaust Duct Rupture
1ZXX-0402-02	Hydrazine Leakage
1ZXX-0402-03	Turbine Failure
1ZXX-0402-04	N_2H_4 Leakage at Umbilical
1ZXX-0402-05	APU Insulation Leak Paths
1ZXX-0402-07	Fitting Leakage N_2H_4
1ZXX-0402-08	Explosion in Exhaust Duct (Start)
1ZXX-0402-09	Failure to Contain Rotating Parts
1ZXX-0402-10	Hydrazine Tank Rupture
1ZXX-0402-12	Failure of Gas Generator
1ZXX-0402-15	N_2H_4 Vapors Overboard/Grnd.
LIFT OFF THRU ORBIT	
1ZXX-0402-01	Exhaust Duct Rupture
1ZXX-0402-02	Hydrazine Leakage
1ZXX-0402-03	Turbine Failure
1ZXX-0402-05	APU Insulation Leak Paths
1ZXX-0402-09	Failure to Contain Rotating Parts
1ZXX-0402-12	Failure of Gas Generator
ON ORBIT	
1ZXX-0402-02	Hydrazine Leakage
DEORBIT THRU LANDING	
1ZXX-0402-01	Exhaust Duct Rupture
1ZXX-0402-02	Hydrazine Leakage
1ZXX-0402-03	Turbine Failure
1ZXX-0402-05	APU Insulation Leak Paths
1ZXX-0402-07	Fitting Leakage N_2H_4
1ZXX-0402-09	Failure to Contain Rotating Parts
1ZXX-0402-12	Failure of Gas Generator

TABLE XIV

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: ELECT. POWER

HAZARD NUMBER	PROBLEM DESCRIPTION
PRELAUNCH	
1YXX-0401-01	LH_2 Leakage at Umbilical
1YXX-0401-02	Cross Coupling of LOX and LH_2
1YXX-0401-03	Ignition Energy - LOX Recir. Pump
1YXX-0401-05	Pressure Vessel Rupture
1ZXX-0401-06	Gas Vapors at Umbilical
1YXX-0401-08	Gas Vapors in Mid Fuselage
1ZXX-0401-10	Press. Vessel/Line Rupture
1YXX-0401-11	Toxic Vapors From Batt.
LIFT OFF THRU ORBIT	
1YXX-0401-03	Ignition Energy - LOX Recir. Pump
1ZXX-0401-04	Interruption of all Elect. Power
1YXX-0401-05	Pressure Vessel Rupture
1YXX-0401-08	Gas Vapors in Mid Fuselage
1ZXX-0401-10	Press. Vessel/Line Rupture
ON ORBIT	
1YXX-0401-03	Ignition Energy - LOX Recir. Pump
1YXX-0401-05	Pressure Vessel Rupture
1YXX-0401-08	Gas Vapors in Mid Fuselage
1ZXX-0401-10	Press. Vessel/Line Rupture
DEORBIT THRU LANDING	
1YXX-0401-03	Ignition Energy - LOX Recir. Pump
1ZXX-0401-04	Interruption of all Elect. Power
1YXX-0401-05	Pressure Vessel Rupture
1ZXX-0401-10	Press. Vessel/Line Rupture
1ZXX-0401-12	H_2 Vapors - Batt. Venting

AVIONICS SYSTEM HAZARD SUMMARY

This volume of the Safety Analysis Report addresses the OV-102 Shuttle Orbiter, Vertical Flight Configuration, Avionics System. Seventy-two HA's have been identified in the Avionics area. The hazard analysis was performed in parallel with design definition and many of these hazards were identified from information in reports such as the Accident/Incident Data Bank and the JSC 00134 Space Flight Hazard Catalog that was available from previous programs. In most cases the initial design incorporated the safety features to eliminate or control these hazards, and the Safety Analysis Report listing was used as a method to check that the safety features were incorporated in the design. Table XV is a summary of the number of hazards in each hazard category for each Avionics group. Table XVI lists each of the hazards identified, by Avionics subsystem, and their disposition. Table XVII is a mission phase breakdown of the HA's. Of the seventy-two hazards identified, sixty-three of these are closed and nine are open, eight of which are in an in-work status and one is a residual hazard.

Residual

1YXX-0501-09, "Redundant Paths not Adequately Separated - IMU's Collocated," addresses the issue wherein the IMU's, for purposes of accuracy and alignment integrity, are located on a common nav base. The risk associated with this design decision - that of a single gross impact and/or collision putting all IMU's out of business - is weighed against the fact that the crew and IMU's share a similar risk environment. The operational need for collocation appears to overrule the exposure to risk exhibited by collocation.

In-Work

1YXX-0501-04, "False Lock-On/Unlock of Star Tracker Optics," with the SAIL verification of stellar position vs. IMU position, periodic drift/rate and magnitude check software and incorporation of initial star ID procedures in the Flight Data File, this hazard will be closed.

1YXX-0501-13, "Failure to Initiate Post ET Separation Orbiter Pitch-Up During RTLS Abort," has been reopened as initial Backup Flight System specifications, MG038100-series, do not provide as yet back-up software in the RTLS abort phase to support a primary system software generic fault. These specifications have not been baselined.

1ZXX-0501-15, "Premature Nose Pitch Down at Roundout - Autoland Function Only." This hazard concerns an erroneous sequence gate entered into the FCS by a failed "Weight-on-Wheels" circuit making the vehicle believe it is on the ground while still airborne. The problem is being handled on the OV-101 through a procedural accommodation. On OV-102, the basic design is being assessed and the design approved to minimize exposure to risk has not been baselined at this time.

1YXX-0502-03, "Leakage of MSBLS KU-Band Wave Circle Through Pressure Bulkhead Reduces Cabin Pressure," this hazard will remain open until successful completion of the vibration and pressure check and qualification tests per AVCO QTP No. 004, Rev. G, provide assurance of waveguide pressure integrity.

1YXX-0506-04, "Inadvertent Pyro Firing Misfiring," inhibition is sensitive to the procedures in the Flight Data File. This hazard will remain open until procedures have been prepared to accommodate the above potential hazard.

1ZXX-0506-08, "Off Schedule 'Arming' or 'Disarming' of Systems," this hazard will remain open until procedures have been prepared to accommodate all "Arm" and "Disarm" conditions in the ALT phase and, later on in the OFT phase.

1ZXX-0506-10, "Failure to Deadface KU-Band Radar Boom Power Circuits Before Guillotining/Jettisoning," this hazard will be closed when the appropriate procedure to, "---- remove power before jettisoning KU-Band Radar Boom" is inserted in the Flight Data File.

1ZXX-0506-14, "Powering up Systems with Latching Relays in Unknown Positions," this hazard closure is sensitive to the procedures that will identify and accommodate the positioning of latching relays prior to powering up the systems. This study is in process.

HAZARD GROUP APPLICATION MATRIX

Avionics Subsystems

HAZARD GROUP	CODE	AVIONICS-GENERAL	GN&C	C&T	D&C	INST.	DATA PROC. & SOFT.	EPDC	COMP.	PMF
LOSS OF PERSONNEL	AA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
COLLISION/IMPACT	BB	N/A	N/A	N/A	1	N/A	N/A	N/A	N/A	N/A
FIRE/EXPLOSION IMPLOSION	CC	1	N/A	2	1	N/A	1	N/A	N/A	N/A
LOSS OF/UNSAFE ENV.	DD	N/A	N/A	1	8	N/A	N/A	N/A	N/A	N/A
CRASH LANDING	EE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LOSS OF FLIG. CONT.	FF	4	13	N/A	10	N/A	2	11	4	N/A
EQUIPMENT FAIL./ DAMAGE	XX	3	N/A	N/A	N/A	N/A	N/A	10	N/A	N/A

N/A - Not Applicable

TABLE XV

TABLE XVI

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR

SUBSYSTEM GROUP	AVIONICS

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
GENERAL							
1ZXX-0500-01	XX	Failure to Key Connectors				X	
1ZXX-0500-02	XX	Use of Counterfeit Parts				X	
1ZXX-0500-03	XX	Use of Wet Tantalum Capacitors				X	
1ZXX-0500-04	FF	Momentary Power Interrupt				X	
1ZXX-0500-05	FF	Transient Power Supply				X	
1ZXX-0500-06	CC	Spurious Ignition Sources				X	
1ZXX-0500-08	FF	Failure of Relays				X	
1YXX-0500-09	FF	Premature/False Initiation of ET Separation Access				X	
GN&C							
1ZXX-0501-02	FF	Loss of IMU Platform Stability				X	
1YXX-0501-04	FF	False Lock-On/Unlock of Star Tracker		X			
1ZXX-0501-06	FF	Inability to Access TAEMS				X	
1ZXX-0501-07	FF	Loss of Rate Gyro Stability				X	
1YXX-0501-08	FF	Loss of Guidance System Accuracy				X	
1YXX-0501-09	FF	Redundant IMU's Collocated			X		
1YXX-0501-11	FF	Improper Air Data/Loss of Air Data				X	
1YXX-0501-12	FF	Exceeding Limit Load Factors/Entry				X	
1YXX-0501-13	FF	Failure to Initiate Post ET Pitch-Up		X			
1ZXX-0501-15	FF	Premature Nose Pitch Down at Round-Out		X			
1YXX-0501-50	FF	False Initiation of SSME Auto Shut-Down				X	
1YXX-0501-54	FF	Failure to Obtain FCS End-To-End Check				X	
1ZXX-0501-57	FF	Failure to Disable MDM Body Flap				X	
C&T							
1ZXX-0502-02	CC	Corona and Arcing					X
1YXX-0502-02-01	CC	Failure of Wave Guide in RCS Bay					X
1YXX-0502-03	DD	MSBLS Ku-Band Wave Guide Leakage		X			
DISPLAYS & CONTROLS							
1ZXX-0503-02	CC	False Fire Alarm					X
1ZXX-0503-03	DD	Failure of C&W to Alert Crew					X
1ZXX-0503-04	FF	Accidental Actuation of Switch					X
1ZXX-0503-05	FF	Insufficient C&W for BFCS Engage					X
1ZXX-0503-07	DD	False Alarm from C&W					X
1ZXX-0503-09	DD	Delay in Back-up C&W					X
1ZXX-0503-10	DD	Bus Failure for C&W					X
1ZXX-0503-11	FF	Insufficient Time to Engage BFCS					X
1ZXX-0503-12	FF	Fail to Engage BFCS and Downmodes					X

(continued)

TABLE XVI

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR

SUBSYSTEM GROUP	AVIONICS

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
DISPLAYS & CONTROLS (Cont.)							
1ZXX-0503-13	FF	Failure in RHC				X	
1YXX-0503-14	DD	Erroneous Alarm				X	
1YXX-0503-15	DD	Failure of Alarm				X	
1YXX-0503-16	DD	Ground Unable to Alert Crew				X	
1YXX-0503-17	BB	Orbiter/Payload Collision - RHC Failure				X	
1YXX-0503-18	FF	Failure to Annunciate OME Out				X	
1YXX-0503-19	FF	Abort Light Illumination Cause Not Easily Discernible				X	
1YXX-0503-20	FF	High "g" Loading May Prevent Control Actuation				X	
1YXX-0503-21	FF	Erroneous Abort Signal				X	
1YXX-0503-22	FF	OME Out Lite May Prematurely Indicate Need to Abort				X	
1YXX-0503-23	DD	CO2 Level Not Annunciated				X	
DATA PROC. & SOFTWARE							
1YXX-0505-02	FF	Single Fault in GPC				X	
1ZXX-0505-03	FF	Overloading of Spacecraft GPC				X	
1ZXX-0505-04	CC	Data Bus Coupler Ignition Source				X	
EPD&C							
1YXX-0506-03	FF	Misfire of NLG Deploy Pyro				X	
1YXX-0506-04	FF	Inadvertent Pyro Firing/Misfiring	X				
1ZXX-0506-05	FF	Inability to Close Speed Brake Elect. Control				X	
1ZXX-0506-06	FF	Lack of Redundant Relays				X	
1ZXX-0506-07	XX	Inadequate Locking of Connectors				X	
1ZXX-0506-08	FF	Off Schedule Arm/Disarm of Systems	X				
1ZXX-0506-09	XX	Failure to Protect Power Supply				X	
1ZXX-0506-10	XX	Failure to Deadface Guillotine Circuits	X				
1ZXX-0506-11	XX	Mating/Demating With Power				X	
1ZXX-0506-12	FF	ET Door Powering Inverter Failure/RTLS				X	
1ZXX-0506-13	XX	Circuit Breakers Slow Acting				X	
1ZXX-0506-14	XX	Unknown Relay State in Start-Up	X				
1ZXX-0506-15	XX	Damage Susceptibility of Wiring Harness				X	
1ZXX-0506-16	XX	Failure to Release LH_2/O_2 Umbilical				X	
1ZXX-0506-17	FF	Remotely Actuated Doors - Power Control Loss				X	
1ZXX-0506-18	FF	Brakes Fail to Actuate				X	
1ZXX-0506-19	XX	Nose Gear Steering System Loss of Contro				X	

(continued)

TABLE XVI

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102

SUBSYSTEM GROUP	AVIONICS

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
EPD&C (Cont.)							
1ZXX-0506-20	XX	Payload Deploy/Retrieve - Power/ Control Loss				X	
1ZXX-0506-21	FF	Loss of Power to Rudder				X	
1ZXX-0506-22	FF	Loss of Power to Body Flap				X	
1ZXX-0506-23	FF	Payload Retention - Power/ControllLoss				X	
COMPUTERS							
1ZXX-0507-01	FF	Power Interrupt Causes Computer Shutdown				X	
1ZXX-0507-03	FF	Manual Override Lock Out				X	
1YXX-0507-04	CC	RCS Commands When Stowed			X		
1ZXX-0507-06	FF	Use of "Loc-Tite" With Magnetic Tape				X	

TABLE XVII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: AVIONICS

HAZARD NUMBER	PROBLEM DESCRIPTION
PRELAUNCH	
1ZXX-0500-01	Failure to Key Connectors
1ZXX-0500-02	Use of Counterfeit Parts
1ZXX-0500-03	Use of Wet Tantalum Capcitors
1ZXX-0500-04	Momentary Power Interrupt
1ZXX-0500-05	Transient Power Supply
1ZXX-0500-06	Spurious Ignition Sources
1ZXX-0500-08	Failure of Relays
1YXX-0500-09	Premature/False Initiation of ET SEP.
1YXX-0501-54	Failure to Obtain FCS Check
1ZXX-0502-02	Corona and Arcing
1ZXX-0503-02	False Fire Alarm
1ZXX-0503-03	Failure of C&W to Alert
1ZXX-0503-07	False Alarm From C&W
1ZXX-0503-09	Delay in Back-up C&W
1ZXX-0503-10	Bus Failure for C&W
1YXX-0503-02	Single Fault in GPC
1ZXX-0505-03	GPC Overload
1ZXX-0505-04	Data Bus Coupler Ignition Source
1YXX-0506-04	Inadvertent Pyro Firing/Misfiring
1ZXX-0506-06	Lack of Redundant Relays
1ZXX-0506-07	Inadequate Locking of Connectors
1ZXX-0506-08	Off Schedule Arming/Disarming of Systems
1ZXX-0506-09	Failure to Protect Power Supply
1ZXX-0506-10	Failure to Deadface Guillotined Circuits
1ZXX-0506-11	Mating/Demating With Power
1ZXX-0506-13	Circuit Breakers Slow Acting
1ZXX-0506-14	Unknown Relay State in Start-Up
1ZXX-0506-15	Demate Susceptibility to Wiring Harness
1YXX-0506-23	Loss of Power to Payload Retention
1YXX-0507-04	RCS Commands When Stowed
1ZXX-0507-06	Use of "Loc-Tite" With Magnetic Tap
LIFTOFF THRU ORBIT	
1ZXX-0500-01	Failure to Key Connectors
1ZXX-0500-02	Use of Counterfeit Parts
1ZXX-0500-03	Use of Wet Tantalum Capacitors
1ZXX-0500-04	Momentary Power Interrupt
1ZXX-0500-05	Transient Power Supply
1ZXX-0500-06	Spurious Ignition Sources

(continued)

TABLE XVII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: AVIONICS

HAZARD NUMBER	PROBLEM DESCRIPTION
LIFTOFF THRU ORBIT (Cont.)	
1ZXX-0500-08	Failure of Relays
1YXX-0500-09	Premature/False Initiation of ET Sep.
1ZXX-0501-02	Loss of IMU Platform Stability
1ZXX-0501-07	Loss of Rate Gyro Stability
1YXX-0501-08	Loss of Guidance System Accuracy
1YXX-0501-09	Redundant IMU's Collocated
1YXX-0501-13	Failure to Initiate Post ET Pitch-up
1YXX-0501-50	False Initiation of SSME Auto Shutdown
1YXX-0501-54	Failure to Obtain FCS Check
1ZXX-0502-02	Corona and Arcing
1ZXX-0503-02	False Fire Alarm
1ZXX-0503-03	Failure of C&W to Alert
1ZXX-0503-04	Accidental Actuation of Switch
1ZXX-0503-05	Insufficient C&W for BFCS Engage
1ZXX-0503-07	False Alarm From C&W
1ZXX-0503-09	Delay in Back-up C&W
1ZXX-0503-10	Bus Failure for C&W
1ZXX-0503-11	Insufficient Time to Engage BFCS
1ZXX-0503-12	Fails to Engage BFCS and Downmodes
1ZXX-0503-13	Failure in RHC
1YXX-0503-14	False Rapid Depress Alarm
1YXX-0503-15	Rapid Depress Alarm Fails
1YXX-0503-18	OMS Alarm for Abort
1YXX-0503-19	Lack of Abort Verification
1YXX-0503-20	"G" Forces in Abort Situation
1YXX-0503-21	Erroneous Abort Light
1YXX-0503-22	OMS Engine Out Causes Abort
1YXX-0503-23	No Alarm for CO_2 Build-up
1ZXX-0505-03	GPC Overload
1ZXX-0505-04	Data Bus Coupler Ignition Source
1YXX-0506-03	Misfire of NLG Pyro
1YXX-0506-04	Inadvertent Pyro Firing/Misfiring
1ZXX-0506-06	Lack of Redundant Relays
1ZXX-0506-07	Inadequate Locking of Connectors
1ZXX-0506-08	Off Schedule Arming/Disarming of Systems
1ZXX-0506-09	Failure to Protect Power Supply
1ZXX-0506-10	Failure to Deadface Guillotined Circuits
1YXX-0506-12	ET Door Powering Inverter Failure
1ZXX-0506-13	Circuit Breathers Slow Acting

(continued)

TABLE XVII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: AVIONICS

HAZARD NUMBER	PROBLEM DESCRIPTION
LIFTOFF THRU ORBIT (Cont.)	
1ZXX-0506-15	Damage Susceptibility to Wiring Harness
1YXX-0506-16	Failure to Release LH_2/O_2 Umbilical
1YXX-0506-17	Remotely Actuated Doors - Power Loss
1ZXX-0506-21	Loss of Power to Rudder
1ZXX-0506-22	Loss of Power to Body Flap
1YXX-0506-23	Loss of Power to Payload Retention
1ZXX-0507-01	Power Interrupt Causes Shutdown
1ZXX-0507-03	Manual Override Lockout
1YXX-0507-04	RCS Commands When Stowed
1ZXX-0507-06	Use of "Loc-Tite" with Magnetic Tape
ON-ORBIT	
1ZXX-0500-01	Failure of Key Connectors
1ZXX-0500-02	Use of Counterfeit Parts
1ZXX-0500-03	Use of Wet Tantalum Capacitors
1ZXX-0500-04	Momentary Power Interrupt
1ZXX-0500-05	Transient Power Supply
1ZXX-0500-06	Spurious Ignition Sources
1ZXX-0500-08	Failure of Relays
1ZXX-0501-02	Loss of IMU Platform Stability
1YXX-0501-04	False Lock-On/Unlock of Star Tracker
1ZXX-0501-07	Loss of Rate Gyro Stability
1YXX-0501-08	Loss of Guidance System Accuracy
1YXX-0501-09	Redundant IMU's Collocated
1ZXX-0502-02	Corona and Arcing
1YXX-0502-02-01	Failure of Waveguide in RCS Bay
1YXX-0502-03	MSBLS KU-Band Waveguide Leakage
1ZXX-0503-02	False Fire Alarm
1ZXX-0503-03	Failure of C&W to Alert
1ZXX-0503-07	False Alarm From C&W
1ZXX-0503-09	Delay in Back-up C&W
1ZXX-0503-10	Bus Failure for C&W
1YXX-0503-14	False Rapid Depress Alarm
1YXX-0503-15	Rapid Depress Alarm Fails
1YXX-0503-16	Ground Station Uplink Alarm
1YXX-0503-17	Payload Collision With Orbiter
1YXX-0503-23	No Alarm for CO_2 Build-up
1ZXX-0505-03	GPC Overload
1ZXX-0505-04	Data Bus Coupler Ignition Source
1YXX-0506-03	Misfire of NLG Pyro
1YXX-0506-04	Inadvertent Pyro Firing/Misfiring
1ZXX-0506-06	Lack of Redundant Relays
1ZXX-0506-07	Inadequate Locking of Connectors
1ZXX-0506-08	Off Schedule Arming/Disarming of Systems
1ZXX-0506-09	Failure to Protect Power Supply

(continued)

TABLE XVII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: AVIONICS

HAZARD NUMBER	PROBLEM DESCRIPTION
ON ORBIT (Cont.)	
1ZXX-0506-10	Failure to Deadface Guillotined Circuits
1ZXX-0506-13	Circuit Breakers Slow Acting
1ZXX-0506-15	Damage Susceptibility to Wiring Harness
1YXX-0506-20	Payload Deploy/Retrieve Control Loss
1YXX-0506-23	Loss of Power to Payload Retention
1YXX-0507-04	RCS Commands When Stowed
1ZXX-0507-06	Use of "Loc-Tite" With Magnetic Tape
DEORBIT THRU LANDING	
1ZXX-0500-01	Failure to Key Connectors
1ZXX-0500-02	Use of Counterfeit Parts
1ZXX-0500-03	Use of Wet Tantalum Capacitors
1ZXX-0500-04	Momentary Power Interrupt
1ZXX-0500-05	Transient Power Supply
1ZXX-0500-06	Spurious Ignition Sources
1ZXX-0501-02	Loss of IMU Platform Stability
1YXX-0501-06	Inability to Access TAEMS
1ZXX-0501-07	Loss of Rate Gyro Stability
1YXX-0501-08	Loss of Guidance System Accuracy
1YXX-0501-09	Redundant IMU's Collocated
1YXX-0501-11	Improper Air Data/Loss of Data
1YXX-0501-12	Exceeding Limit Load Factors
1YXX-0501-13	Failure to Initiate Post ET Pitch-Up
1ZXX-0501-15	Premature Pitch Down at Round Out
1YXX-0501-54	Failure to Obtain FCS Check
1ZXX-0501-57	Failure to Disable Body Flap
1ZXX-0502-02	Corona and Arcing
1YXX-0502-02-01	Failure of Waveguide in RCS Bay
1ZXX-0503-02	False Fire Alarm
1ZXX-0503-03	Failure to C&W to Alert
1ZXX-0503-04	Accidental Actuation of Switch
1ZXX-0503-05	Insufficient C&W for BFCS Engage
1ZXX-0503-07	False Alarm From C&W
1ZXX-0503-09	Delay in Back-up C&W
1ZXX-0503-10	Bus Failure for C&W
1ZXX-0503-11	Insufficient Time to Engage BFCS
1ZXX-0503-12	Fails to Engage BFCS and Downmodes

(continued)

TABLE XVII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: AVIONICS

HAZARD NUMBER	PROBLEM DESCRIPTION
DEORBIT THRU LANDING (Cont.)	
1ZXX-0503-13	Failure in RHC
1YXX-0503-14	False Rapid Depress Alarm
1YXX-0503-15	Rapid Depress Alarm Fails
1YXX-0503-23	No Alarm for CO_2 Build-up
1ZXX-0505-03	GPC Overload
1ZXX-0505-04	Data Bus Coupler Ignition Source
1YXX-0506-03	Misfire of NLG Pyro
1YXX-0506-04	Inadvertent Pyro Firing/Misfiring
1ZXX-0506-05	Inability to Close Speedbrake
1ZXX-0506-06	Lack of Redundant Relays
1ZXX-0506-07	Inadequate Locking of Connectors
1ZXX-0506-08	Off Schedule Arming/Disarming of Systems
1ZXX-0506-09	Failure to Protect Power Supply
1ZXX-0506-10	Failure to Deadface Guillotined Circuits
1ZXX-0506-13	Circuit Breakers Slow Acting
1ZXX-0506-14	Unknown Relay State in Start-up
1ZXX-0506-15	Damage Susceptibility to Wiring Harness
1ZXX-0506-17	Remotely Actuated Doors - Power Loss
1ZXX-0506-18	Brakes Fail to Actuate
1ZXX-0506-19	Nose Gear Steering Control Loss
1ZXX-0506-21	Loss of Power to Rudder
1ZXX-0506-22	Loss of Power to Body Flap
1YXX-0506-23	Loss of Power to Payload Retention
1ZXX-0507-01	Power Interrupt Causes Shutdown
1ZXX-0507-03	Manual Override Lockout
1YXX-0507-04	RCS Commands When Stowed
1ZXX-0507-06	Use of "Loc-Tite" with Magnetic Tape

ECLSS SYSTEM HAZARD SUMMARY

This volume of the Safety Analysis Report addresses the OV-102 Shuttle Orbiter, Vertical Flight Configuration, ECLSS System. Eighteen HA's have been identified in the ECLSS area. The hazard analysis was performed in parallel with design definition and many of these hazards were identified from information in reports such as the Accident/Incident Data Bank and the JSC 01134 Space Flight Hazard Catalog that was available from previous programs. In most cases the initial design incorporated the safety features to eliminate or control these hazards, and the Safety Analysis Report listing was used as a method to check that the safety features were incorporated in the design. Table XVIII is a summary of the number of hazards in each hazard category for each ECLSS group. Table XIX lists each of the hazards identified, by ECLSS subsystem, and their disposition. Table XX is a mission phase breakdown of the HA's. Of the eighteen hazards identified, seventeen of these are closed and one is open and in an in-work status. There are no residual hazards.

OPEN HAZARDS - IN WORK

1YXX-0603-03, "Failure to Provide Adequate Cooling," This potential hazard discusses loss of both Freon 21 coolant loops; excessive heat load; failure of ammonia boiler system, flash evaporator or space radiators; and freezing in the interchanger. When evaluation of maximum heat load and heat rejection rates and definition of mission constraints are completed, and Certification Plan SD74-SH-0039 is released, this potential hazard will be closed.

HAZARD GROUP APPLICATION MATRIX

Environmental Control & Life Support Systems

Hazard Group	Code	Atmos. Revital.	Life Support	Smoke Detect/ Fire Suppress.	Active Thermal Control	Airlock
Loss of Personnel	AA	N/A	1	2	N/A	N/A
Collision/Impact	BB	N/A	N/A	N/A	N/A	N/A
Fire/Explosion/Implosion	CC	1	N/A	N/A	1	N/A
Loss of/Unsafe Environment	DD	3	1	4	1	1
Crash Landing	EE	N/A	N/A	N/A	N/A	N/A
Loss of Flight Control	FF	1	1	N/A	1	N/A
Other	XX	N/A	N/A	N/A	N/A	N/A

N/A - Not Applicable

TABLE XVIII

TABLE XIX

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR

SUBSYSTEM GROUP	ENVIRONMENT CONTROL & LIFE SUPPORT

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
ATMOSPHERIC REVITALIZATION							
1ZXX-0601-01	DD	Loss of Compartment Air Control					X
1ZXX-0601-01-01	DD	Failure to Remove CO_2					X
1ZXX-0601-02	FF	Loss of Avionics Cooling					X
1YXX-0601-03	DD	Loss of Proper Cabin Air					X
1YXX-0601-03-02	CC	O_2/N_2 Tank Explosion					X
LIFE SUPPORT							
1YXX-0602-01	FF	Shorting of Electrical Equipment (free water)	X				
1YXX-0602-02	AA	Contamination of Potable Water					X
1YXX-0602-03	DD	Failure to Remove Bacteria and Odors					X
SMOKE DETECTION & FIRE SUPPRESSION							
1ZXX-0602-04-02	DD	False Smoke Indication					X
1ZXX-0602-04-04	DD	Fire Suppression Syst. Fails to Extinguish					X
1ZXX-0602-04-05	DD	Premature Oper. of Fire Suppression					X
1YXX-0602-04-06	AA	Non-Restraint of Operator During Use of Portable Fire Extinguisher in Zero "G"					X
1ZXX-0602-04-07	AA	Unsafe/Ineffective Oper. of Fire Extinguisher Syst.					X
1YXX-0602-04-08	DD	Syst. Fails to Detect Smoke					X
ACTIVE THERMAL CONTROL							
1YXX-0603-03	FF	Failure to Provide Adequate Cooling		X			
1YXX-0603-05	CC	Ammonia Tank Rupture					X
1YXX-0603-06-01	DD	Ammonia Inhalation					X
AIRLOCK							
1YXX-0604-01	DD	Loss of Life Support - Airlock					X

TABLE XX

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: ECLSS

HAZARD NUMBER	PROBLEM DESCRIPTION
PRELAUNCH	
1ZXX-0601-01	Loss of Compartment Air Control
1ZXX-0601-01-01	Failure to Remove CO_2
1ZXX-0601-02	Loss of Avionics Cooling
1YXX-0601-03	Loss of Proper Cabin Air
1YXX-0601-03-02	O_2/N_2 Tank Explosion
1YXX-0602-01	Contaminated Water For Food
1YXX-0602-02	Contamination of Potable Water
1ZXX-0602-04-01	System Fails to Detect Smoke
1ZXX-0602-04-03	Fire Suppression Fails to Operate
1ZXX-0602-04-04	Fire Suppression Syst. Fails to Extinguish
1ZXX-0602-04-05	Premature Operation of Fire Suppression
1ZXX-0602-04-07	Unsafe/Ineffective Oper. of Fire Extinguisher System
1YXX-0603-03	Failure to Provide Adequate Cooling
1YXX-0603-05	Ammonia Tank Rupture
1YXX-0604-01	Loss of Life Support - Airlock
LIFT OFF THRU ORBIT	
1ZXX-0601-01	Loss of Compartment Air Control
1ZXX-0601-01-01	Failure to Remove CO_2
1ZXX-0601-02	Loss of Avionics Cooling
1YXX-0601-03	Loss of Proper Cabin Air
1YXX-0601-03-02	O_2/N_2 Tank Explosion
1YXX-0602-01	Loss of Flt. Control
1YXX-0602-02	Contamination of Potable Water
1YXX-0602-03	Failure to Remove Bacteria and Odors
1ZXX-0602-04-01	System Fails to Detect Smoke
1ZXX-0602-04-04	Fire Suppression Syst. Fails to Extinguish
1ZXX-0602-04-05	Premature Operation of Fire Suppression
1YXX-0603-03	Failure to Provide Adequate Cooling
1YXX-0603-05	Ammonia Tank Rupture
1ZXX-0604-01	Loss of Life Support - Airlock
ON ORBIT	
1ZXX-0601-01	Loss of Compartment Air Control
1ZXX-0601-01-01	Failure to Remove CO_2
1ZXX-0601-02	Loss of Avionics Cooling
1YXX-0601-03	Loss of Proper Cabin Air

(continued)

TABLE XX

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: ECLSS

HAZARD NUMBER	PROBLEM DESCRIPTION
ON ORBIT (Cont.)	
1YXX-0601-03-02	O_2/H_2 Tank Explosion
1YXX-0602-01	Contaminated Water for Food
1YXX-0602-02	Contamination of Potable Water
1YXX-0602-03	Failure to Remove Bacteria and Odors
1ZXX-0602-04-01	System Fais to Detect Smoke
1ZXX-0602-04-03	Fire Suppression Fails to Operate
1ZXX-0602-04-04	Fire Suppression System Fails to Extinguish
1ZXX-0602-04-05	Premature Operation of Fire Suppression
1YXX-0602-04-06	Non-Restraint of Operator During Use of Portable Fire Extinguisher in Zero "G"
1ZXX-0602-04-07	Unsafe/Ineffective Operation of Fire Extinguisher System
1YXX-0603-03	Failure to Provide Adequate Cooling
1YXX-0603-05	Ammonia Tank Rupture
1YXX-0604-01	Loss of Life Support - Airlock
DE-ORBIT THRU LANDING	
1ZXX-0601-01	Loss of Compartment Air Control
1ZXX-0601-01-01	Failure to Remove CO_2
1ZXX-0601-02	Loss of Avionics Cooling
1YXX-0601-03	Loss of Proper Cabin Air
1YXX-0601-03-02	O_2/N_2 Tank Explosion
1YXX-0602-02	Contamination of Potable Water
1YXX-0602-03	Failure to Remove Bacteria and Odors
1ZXX-0602-04-01	System Fails to Detect Smoke
1ZXX-0602-04-03	Fire Suppression Fails to Operate
1ZXX-0602-04-04	Fire Suppression Syst. Fails to Extinguish
1ZXX-0602-04-05	Premature Operation of Fire Suppression
1ZXX-0602-04-06	Non-Restraint of Operator During Use of Portable Fire Extinguisher in Zero "G"
1ZXX-0602-04-07	Unsafe/Ineffective Oper. of Fire Extinguisher System
1YXX-0603-03	Failure to Provide Adequate Cooling
1YXX-0603-05	Ammonia Tank Rupture
1YXX-0603-06-01	Ammonia Inhalation
1YXX-0604-01	Loss of Life Support - Airlock

CREW STATION AND EQUIPMENT SYSTEM HAZARD SUMMARY

This volume of the Safety Analysis Report addresses the OV-102 Shuttle Orbiter, Vertical Flight Configuration, Crew Station and Equipment (CS&E) System. Twenty HA's have been identified in the CS&E area. The hazard analysis was performed in parallel with design definition and many of these hazards were identified from information in reports such as the Accident/Incident Data Bank and the JSC 00134 Space Flight Hazard Catalog that was available from previous programs. In most cases the initial design incorporated the safety features to eliminate or control these hazards, and the Safety Analysis Report listing was used as a method to check that the safety features were incorporated in the design. Table XXI is a summary of the number of hazards in each hazard category for each CS&E group. Table XXII lists each of the hazards identified, by CS&E subsystem, and their disposition. Table XXIII is a mission phase breakdown of the HA's. Of the twenty hazards identified, thirteen of these are closed and seven are open, five of which are in an in-work status and two are residual hazards.

RESIDUAL HAZARDS

1YXX-0712-1A "Insecurity of Stowage Container Mounting." This hazard has been classified as a residual hazard due to the lack of visual capability to verify that all containers are properly secured to their mountings. Prior to a mission, stowage containers will be installed and while on-orbit they may be temporarily removed and then reinstalled prior to reentry. The installation of containers involves securement of the container to its mount by use of blind fasteners. Therefore, a final visual check cannot be made to insure that all fasteners have been engaged and properly tightened.

1VXX-0721-2A "Ejected Panel Strikes Ground Personnel and/or Property." This hazard has been classified as a residual hazard due to the unpredictability of ejection occurrence. However, this hazard can be minimized by pre-planning including flight path programming to avoid populated areas and ground rescue procedural cautions with respect to ejected panel contacts.

OPEN HAZARDS - IN WORK

1YXX-0710-03 "Emergency Egress Device Failure." This hazard was originally identified as an OV-101 and subs concern (H/A 1ZXX-0710-1C). Due to OV-102 and subs design differences inside hatch egress provisions - increased number of Sky Genies required for flight deck egress, and hot TPS contact with Sky Genie descent lines - this concern has been reidentified by this new HA effective OV-102 and subs, and is still in work.

1ZXX-0716-1B "Damage to ETS Lines Because of Inadequate Protection." This hazard has been reopened (1-19-76) for the purpose of identifying an additional hazard cause relating to potential damage of energy transfer system (ETS) lines. ETS lines are susceptible to damage from bending and impact as a result of exposure to kicking, snagging or handhold usage. This damage is not visually detectible and can render the crew escape system inoperative. It is therefore important that these lines be shielded or guarded from abuse. Closeout panels have been provided for OV101 and design is in progress to satisfy this required protection for OV102 (Ref. MCR 2497).

1YXX-0717-06 "POS Inaccessibility." This is a new HA that is concerned with providing on station usage capability during all critical mission phases. Design is investigating possible mounting locations that will permit immediate in-place usage during an emergency.

1VXX-0721-13 "Flying Objects Caused by Decompression Effect from Panel Jettison During High Altitude Ejections." This hazard relates to possible direct injury to crewmen or interference with the safe functioning of the ejection seat system. Action to resolve this problem is currently in progress under authorization by MCR 3164.

1VXX-0721-14 "Ejection Seat Aneroid Damage from Crew Compartment Pressure Tests (MCR 1983)." The aneroids, which control main chute deployment, are not presently qualified for exposure to overpressures. Overpressure damage to the aneroids could result in malfunction of main chute deployment. Testing is in progress to insure that the aneroids will not be adversely affected by anticipated crew compartment pressure testing.

HAZARD GROUP APPLICATION MATRIX

Crew Station and Equipment

Hazard Group	Code	Mobility Aids & Devices	Emerg. Egress Devices	Stow-age	Equip. Mount.	Emerg. Equip.	Escape System	Escape System Safing
Loss of Personnel	AA	1	N/A	N/A	N/A	N/A	9	1
Collision/Impact	BB	N/A	1	1	1	N/A	5	N/A
Loss of/Unsafe Environment	DD	N/A	N/A	N/A	N/A	1	N/A	N/A

N/A = Not Applicable

TABLE XXI

TABLE XXII

HAZARD ANALYSIS SUMMARY

MODEL	SHUTTLE ORBITER OV-102 CDR

SUBSYSTEM GROUP	CREW STATION & EQUIPMENT

HAZARD NUMBER	HAZARD GROUP	PROBLEM DESCRIPTION	STATUS: OPEN: IN-WORK	OPEN: RESIDUAL	CLOSED: ELIMINATED	CLOSED: CONTROLLED	CLOSED: ACCEPTED
MOBILITY AIDS & DEVICES							
1ZXX-0708-1C	AA	Failure of Device				X	
EMERGENCY EGRESS DEVICES							
1YXX-0710-03	BB	Failure of Device	X				
STOWAGE							
1YXX-0712-1A	BB	Failure of Mountings		X			
EQUIPMENT MOUNTING							
1ZXX-0716-1B	BB	Failure of Mount, Att, Etc.	X				
EMERGENCY EQUIP.							
1YXX-0717-06	DD	Pos. Inaccessibility	X				
ESCAPE SYSTEM							
1VXX-0721-1C	AA	Ejection Panel Failure				X	
1VXX-0721-2A	AA	Eject. Panel Strikes Personnel		X			
1VXX-0721-3B	AA	Ejection Seat Failure				X	
1YXX-0721-4B	AA	Premature Ejection				X	
1VXX-0721-5A	BB	Ejection Seats Collide				X	
1VXX-0721-6B	BB	Ejection Seat Rail Failure				X	
1VXX-0721-7A	BB	Rail Fail. During Crash Landing				X	
1VXX-0721-8A	AA	Ejection Panel Control Accessibility				X	
1VXX-0721-9C	AA	Inability of 60 Sec. Emerg. Egress				X	
1VXX-0721-10A	BB	Seat-To-Ejec. Panel Collision				X	
1VXX-0721-11	AA	Premature Chute Deployment				X	
1YXX-0721-12C	AA	Back Wedge Retract Failure				X	
1VXX-0721-13	BB	Flying Objects During Eject.	X				
1VXX-0721-14	AA	Main Chute Deployment Failure	X				
ESCAPE SYSTEM SAFING							
1VXX-0722-1A	AA	Accidental Seat Ejection				X	

TABLE XXIII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: CREW STATION & EQUIPMENT

HAZARD NUMBER	PROBLEM DESCRIPTION
PRELAUNCH	
1ZXX-0708-1C	Failure of Device
1ZXX-0716-1B	Failure of Mount, Att, Etc.
1YXX-0717-06	Pos. Inaccessibility
1VXX-0721-9C	Inability of 60 Sec. Emerg. Egress
1VXX-0721-14	Main Chute Deployment Failure
1VXX-0722-1A	Accidental Seat Ejection
LIFT OFF THRU ORBIT	
1YXX-0712-1A	Failure of Mountings
1ZXX-0716-1B	Failure of Mount, Att, Etc.
1YXX-0717-06	Pos. Inaccessibility
1VXX-0721-1C	Ejection Panel Failure
1VXX-0721-2A	Eject. Panel Strikes Personnel
1VXX-0721-BB	Ejection Seat Failure
1VXX-0721-5A	Ejection Seat Collision
1VXX-0721-6B	Eject. Seat Rail Failure
1VXX-0721-10A	Seat/Ejection Panel Collison
1VXX-0721-11	Premature Chute Deployment
1YXX-0721-12C	Back Wedge Retract Failure
1VXX-0721-13	Flying Objects During Ejection
1VXX-0721-14	Main Chute Deployment Failure
ON ORBIT	
1ZXX-0708-1C	Failure of Device
1YXX-0712-1A	Failure of Mountings
1ZXX-0716-1B	Failure of Mount, Att, Etc.
1YXX-0717-06	Pos. Inaccessibility
1YXX-0721-4B	Premature Ejection
DE-ORBIT THRU LANDING	
1YXX-0710-03	Failure of Device
1YXX-0712-1A	Failure of Mountings
1ZXX-0716-1B	Failure of Mount, Att, Etc.
1YXX-0717-06	Pos. Inaccessibility
1VXX-0721-1C	Ejection Panel Failure
1VXX-0721-2A	Eject. Panel Strikes Personnel

(continued)

TABLE XXIII

HAZARD ANALYSIS MISSION PHASE LISTING

SUBSYSTEM GROUP: CREW STATION & EQUIPMENT

HAZARD NUMBER	PROBLEM DESCRIPTION
DE-ORBIT THRU LANDING (Cont.)	
1VXX-0721-3B	Ejection Seat Failure
1VXX-0721-5A	Ejection Seat Collison
1VXX-0721-6B	Ejection Seat Rail Failure
1VXX-0721-7A	Rail Fail. During Crash Landing
1VXX-0721-8A	Eject. Panel Control Accessibility
1VXX-0721-9C	Inability of 60 Sec. Emerg. Egress
1VXX-0721-10A	Seat/Eject. Panel Collision
1VXX-0721-11	Premature Chute Deployment
1YXX-0721-12C	Back Wedge Retract Failure
1VXX-0721-13	Flying Objects During Eject.
1VXX-0721-14	Main Chute Deployment Failure